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CARTOGRAPHIC DATA ACQUISITION AND SUPPORTING ACTIVITIES:
HYDROGRAPHIC SURVEYING AND NAUTICAL CHARTING

Ocean mapping activities of the Intergovernmental
Oceanographic Commission**

Paper submitted by the Intergovernmental Oceanographic
Commission***

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** Copies of the report of the IOC ad hoc Group of Experts on Ocean Mapping in the WESTPAC region, Tianjin, China, June 1990 (IOC/GE-IBCWP-I/3) which gives more information on IOC's plans for an International Bathymetric Chart of the western Pacific will be made available. However, the project is in an early stage of development and awaits approval by the IOC Assembly at its sixteenth session in March 1991.

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1. BACKGROUND

The bottom of the World's Oceans covers more than two thirds of the surface of the globe, and its relief is more complicated than that of the land because it is less subject to changes wrought by erosion. Besides this, the oceanic crust is much younger than continental blocks and is not so thick. For these reasons the roughness of the ocean bottom is more strongly expressed.

The latest technological achievements in cartography on land, particularly the use of remote sensing, cannot be applied to the development of marine cartography because of the impenetrability of ocean water masses by light beams. This is why at the present time the topography of the seafloor is not as well known as the topography of the far side of the moon.

But the need for exploitation of ocean resources increases each year, and requires careful regulation based upon a detailed knowledge of the marine environment.

One of the first and most important steps in the exploration of the oceans is the preparation of bathymetric charts showing the topography of the ocean bottom in as much detail as possible. For this reason, ocean mapping has made considerable progress in recent years and has become one of IOC's major activities.

But for compilation of bathymetric charts a knowledge of the measured depth alone is not enough. Knowledge of the geomorphology, geology and sedimentology of the seafloor is also essential; for this reason the involvement of the IOC scientific community is therefore extremely important. On the other hand, the production of bathymetric charts can also be a stimulus to the research of many marine scientists because the topography of the seafloor strongly influences physical, chemical and biological processes, especially in the near bottom layers.

The great majority of existing bathymetric data still in use today is of low quality by modern standards. Uncertainties in the determination of ship's position limit the accuracy of the isobaths.

The IOC, working in close collaboration with the International Hydrographic Organization, co-ordinates international efforts to archive all existing available data, to undertake additional investigations in some regions, and to compile and print bathymetric charts to meet the needs of all types of ocean users.

All bathymetric charts compiled under the aegis of the IOC are prepared to a common standard in regard to cartographic specifications and legends. They are all designed to meet the following requirements:

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- (i) Simple, easy to read, clear;
- (ii) Provision of correct and comprehensive information on the bottom topography;
- (iii) Provision of the most detailed and accurate value available for the depth at any point on the sheet.

In recent years, many national and international organizations have taken on the task of compiling charts for various ocean regions. In certain cases this has been undertaken principally to facilitate the exploitation of particular ocean resources. The IOC's aim is to ensure a planned approach to the long-term mapping of the world seabed, not only to meet current needs but in the perspective of the long-term development of ocean sciences and services.

In general for any given ocean region, a bathymetric chart is first compiled which serves as a base chart; following this, geological and geophysical maps (overprinted on the base chart) are prepared. The same base chart can also be used for the compilation of charts showing the distribution and circulation of water masses and of living and non-living resources.

The IOC has been active in Ocean Mapping since the United Nations General Assembly endorsed, by Resolution 2560 (XXIV) in December 1969, the Long-term and Expanded Programme of Oceanic Exploration and Research (LEPOR). In 1970 the compilation of a Geological/Geophysical Atlas of the Indian Ocean was started (published 1975) in order to compile in map form the findings of the International Indian Ocean Expedition (IIOE). In 1972 the IOC and the International Hydrographic Organization (IHO) agreed to co-sponsor the production of a new (fifth) edition of the General Bathymetric Chart of the Oceans (GEBCO). The GEBCO (5th Edition), published in 1982 by the Canadian Hydrographic Service (on behalf of IOC and IHO), consists of 19 sheets depicting the bathymetry and morphology of the world's oceans; this series takes advantage for the first time of the development of new concepts of global tectonics and modern navigational systems.

In 1973, following IOC Resolution VIII-11, a group of experts was set up to prepare a large-scale bathymetric base chart of the Mediterranean and Black Seas. With the co-operation of the IHO, national hydrographic services and individual scientists, the First Edition of the International Bathymetric Chart of the Mediterranean (IBCM) was printed and published by the Head Department of Navigation and Oceanography, Leningrad, on behalf of the IOC, in 1982. IBCM Geological-Geophysical series are in course of preparation.

The IOC has now set up an effective structure of subsidiary groups and editorial boards for its Ocean Mapping programme. The activities of the various groups are described in the remaining sections of this paper.

2. THE CONSULTATIVE GROUP ON OCEAN MAPPING (CGOM)

At its Seventeenth Session in January-February 1984, the IOC Executive Council established the Consultative Group on Ocean Mapping (CGOM), as it had become apparent that there was a need to have within the structure of the IOC an appropriate advisory body formed of highly-qualified scientists in the field of ocean mapping and related activities, to act as an overall technical mechanism linking together the diverse ocean mapping projects with which the Commission is involved.

The CGOM is composed of the Chairmen of all the supervisory groups and editorial boards of the Ocean Mapping projects sponsored or co-sponsored by the Commission. It meets to discuss current developments and reports biennially to the IOC Assembly.

3. GENERAL BATHYMETRIC CHART OF THE OCEANS (GEBCO)

The General Bathymetric Chart of the Oceans was initiated at the beginning of the century by Prince Albert I of Monaco. The first edition was published in 1903. The success of the chart inspired scientists to continue preparations for further editions. By 1972, four editions had been either completely or partially published, but then, following a strong recommendation from the Scientific Committee on Oceanic Research (SCOR) on content and general requirements, the IOC and the IHO agreed to co-sponsor an entirely new (fifth) edition, to be compiled by marine scientists, incorporating the best available bathymetric data and employing the latest geological and geophysical knowledge of the structure of the seafloor.

A Joint IOC-IHO Guiding Committee for the GEBCO was established consisting of ten members, five nominated by IOC and five by IHO. The IOC experts are nominated after consultation with the Scientific Committee on Oceanic Research (SCOR), the International Association for the Physical Sciences of the Ocean (IAPSO) and the Commission for Marine Geology (CMG). The IHO experts are selected from Volunteering Hydrographic Offices (VHOs).

With such close collaboration between scientists and hydrographers, the Fifth Edition of GEBCO was completed by 1982; it consists of 16 sheets on Mercator projection at a scale of 1:10 million (at the equator), 2 sheets on Polar Stereographic projection at a scale of 1:6 million (at 75° latitude), and, published in 1984, the World's Oceans in one sheet, on Mercator projection at a scale of 1:35 million (at the equator) with the polar regions at a scale of 1:25 million (at 75° latitude).

A GEBCO Sub-Committee on Geographical Names and Nomenclature of Ocean Bottom Features was set up at the same time as the Guiding Committee to oversee the standardization of nomenclature used for ocean bottom features, together with their geographical names. In late-1988 a "Gazetteer of Geographical Names of Undersea Features shown (or which might be added) on the

GEBCO and on the IHO small-scale International Chart Series" was published in English and French. This incorporates the English/French version of a publication "Standardization of Undersea Feature Names"; English/Russian and English/Spanish versions have been published separately. English/Chinese, English/German, English/Japanese and English/Portuguese versions are in preparation.

The Guiding Committee has concluded that the future of the GEBCO lies with the development of a continuously updated digital bathymetric contour database, together with appropriate sub-files. Products from the database are marketed using current technology, and a new edition of the traditional GEBCO printed map series will be published from time to time as appropriate, and when funds permit.

This database, which will be easily accessible and user friendly, has now been named the "GEBCO Digital Atlas". Initially it will consist of a collection of digitized bathymetric contour maps of the world's oceans, with sub-files for track control, and a gazetteer of undersea feature names. Later, it is planned to add a Digital Terrain Model and/or a gridded data set, and to create a CD-ROM for use on Personal Computers (PCs).

Magnetic tapes of digitized bathymetric contours of certain regions are already available, and the "GEBCO Digital Atlas" is expected to be fully operational by mid-1991 (see Annex I). A new 6th Edition of the GEBCO traditional printed paper chart is now scheduled for publication in 1995.

4. INTERNATIONAL GEOLOGICAL/GEOPHYSICAL ATLASES OF THE ATLANTIC AND PACIFIC OCEANS (GAPA)

The Geological/Geophysical Atlas of the Indian Ocean was published in 1975, under the overall supervision of the IOC, to bring together all data collected during the International Indian Ocean Expedition (1959-1965).

Further atlases in this series consist of an Atlantic ocean atlas (published 1990) and a Pacific Ocean atlas (in preparation and scheduled for publication by the end of 1993). The numerous maps therein of various parameters are being compiled by eminent marine geologists and geophysicists working in leading scientific institutions throughout the world.

5. INTERNATIONAL BATHYMETRIC CHART OF THE MEDITERRANEAN AND ITS GEOLOGICAL/GEOPHYSICAL SERIES (IBCM)

The IBCM was the first IOC regional mapping project. It was initiated by scientists participating in the joint IOC/ICSEM/FAO Co-operative Investigations in the Mediterranean (CIM), in the early 1970s, and it can be said that at the present time the Mediterranean has become one of the best explored regional seas in the world, from the point of view of cartography of the sea bottom.

Several bathymetric charts of limited areas already existed at that time, some on scales as large as 1:200,000. However, development of high precision echo-sounding and positioning techniques made it possible to collect a large amount of new data in a relatively short space of time. This became an essential premise for the preparation of high quality bathymetric charts of the Mediterranean on a scale of 1:1 million (at 38° North). The chart, consisting of ten sheets on Mercator projection, was printed and published by the Head Department of Navigation and Oceanography, Leningrad, on behalf of IOC, in 1982.

Specifications prepared for compilation of the IBCM have been revised from time-to-time and in 1986 they were adopted by the Consultative Group on Ocean Mapping as "Specifications for International Bathymetric Charts produced under IOC Regional Mapping Projects".

The IBCM contours have been digitized and are now available on magnetic tape to the scientific community at a "symbolic" royalty and reproduction costs.

After the publication of the IBCM, the 1:250,000 plotting sheets were, at the request of the IOC, transferred to the World Data Centre for Bathymetry (IHO). Subsequently, they were distributed to a number of IHO's Volunteering Hydrographic Offices (VHOs) for updating and continued maintenance, with a view to publication of a 2nd Edition of the bathymetric chart later.

Results of the first surveys in the Mediterranean using swath sounding systems, i.e. SEABEAM, SeaMARC, Hollming ECHOS, etc., have recently been received by the WDC Bathymetry, e.g. a survey south of Cyprus carried out by the Soviet R/V "Akademik Nikolai Strakhov". It is expected that in due course a large area of the Mediterranean will be covered by such surveys and that the data will be used by the VHOs for updating the bathymetric database.

Following publication of the IBCM, it was decided to publish five separate geological/geophysical map series (of ten sheets each on the same scale), using the IBCM bathymetry as a base, as follows:

- (i) Bouguer Gravity anomalies;
- (ii) Seismicity;
- (iii) Plio-Quaternary/Messinian Structure;
- (iv) Unconsolidated Sea-Bed Sedimentation;
- (v) Magnetic anomalies.

The first series (Gravity) has recently been published. The second series (Seismicity) is in press and is scheduled for publication by mid-1991. The other three series are expected to appear thereafter at the rate of one further series a year.

6. INTERNATIONAL BATHYMETRIC CHART OF THE CARIBBEAN SEA AND GULF OF MEXICO (IBCCA)

Preparation of the bathymetric chart covering the Caribbean Sea, Gulf of Mexico and adjacent regions was initiated in 1986. The approved Assembly Diagram provides for 17 sheets on a scale of 1:1 million (at 15° N.). Compilation of a number of sheets has already started and it is expected that the northern ten sheets will be completed by 1992. A colour proof copy of the first of those sheets was printed in 1991.

The IBCCA region has been divided into regions of responsibility for each of the participating countries. The leading role, and responsibility for the final scribing, editing and printing of the chart series has been assumed by the Instituto Nacional de Estadística, Geografía e Informática, México.

7. INTERNATIONAL BATHYMETRIC CHART OF THE WESTERN INDIAN OCEAN (IBCWIO)

An Editorial Board for this region has been established with members from countries of the region and other interested countries. Its First Session was held in April 1989 in Antananarivo, Madagascar. At this Session decisions were reached on the overall limits of the region to be charted, the Assembly Diagram showing sheet limits, availability of data, and responsibilities of participating countries.

During the Second Session (July 1990, Mauritius), the first results of the collection and plotting of data were discussed. Plotting sheets of two large areas of the IBCWIO region were displayed for consideration.

The leading role, including provision of the Chief Editor, in editing, printing and publication of this series has been assumed by the Bundesamt für Seeschifffahrt und Hydrographie (BSH), Hamburg, Federal Republic of Germany.

8. INTERNATIONAL BATHYMETRIC CHART OF THE CENTRAL EASTERN ATLANTIC (IBCEA)

An Editorial Board for the IBCEA was established by the IOC Assembly at its Fourteenth Session in March/April 1987.

The Editorial Board during its First Session (February 1990, Nigeria) adopted an Assembly Diagram consisting of 12 sheets to be published by the Hydrographic Services of France and Portugal on behalf of IOC. It was also decided that a digital version of each sheet would be published at the same time as the printed version.

The project will consist of four successive stages:

- a) Data Collection - this stage is now operational;
- b) Data Quality Control;
- c) Geomorphological Interpretation;
- d) Printing and Publication of the Chart.

9. **INTERNATIONAL BATHYMETRIC CHART OF THE WESTERN PACIFIC (IBCWP)**

A meeting of an IOC ad hoc Group of Experts on Ocean Mapping in the WESTPAC Region was held in June 1990 (Tianjin, People's Republic of China).

The Group adopted a recommendation to the IOC Assembly, proposing the creation of this project and the establishment of an Editorial Board for this purpose.

The Group drafted "Specifications for the IBCWP" to be adopted by the Editorial Board".

In view of the large area covered by the WESTPAC Region, the western (marginal) part was divided into six subregions (see Annex II). The compilation, printing and publishing of sheets from these subregions will need to be implemented in different ways, and further negotiations will be needed before the overall mechanisms of implementation can be finalized.

10. **OTHER POSSIBLE REGIONAL OCEAN MAPPING PROJECTS**

Plans for the preparation of an International Bathymetric Chart of the Red Sea and Gulf of Aden have been drawn up, with the Institute of Oceanographic Sciences Deacon Laboratory, United Kingdom, acting as the lead agency. The project is in abeyance at the present time awaiting identification of the necessary funding source.

The project consists of the base bathymetric series in eleven sheets at a scale of 1:500,000 (at 20°N.) and three separate geological/geophysical map series (of 11 sheets each on the same scale), as follows:

- (i) Gravity anomalies;
- (ii) Magnetic anomalies (showing seismicity and isochrons on the observe);
- (iii) Isopachs (Sediment Thickness).

At meetings of relevant IOC Regional Committees, proposals have been put forward for International Bathymetric Charts of:

- (i) The Central Indian Ocean;
- (ii) The Antarctic (Southern Oceans).

No firm plans yet exist for these areas.

11. CONCLUSION

As each large-scale regional bathymetric project is completed, it is intended to digitize the contours and other ancillary material. These will then be incorporated into the GEBCO Digital Atlas to replace contours digitized from the smaller scale GEBCO sheets.

The "GEBCO Digital Atlas", together with the recent establishment of an IHO International Data Centre for Digital Bathymetry, will also facilitate the preparation of Digital Terrain Models (DTMs) of the seafloor.

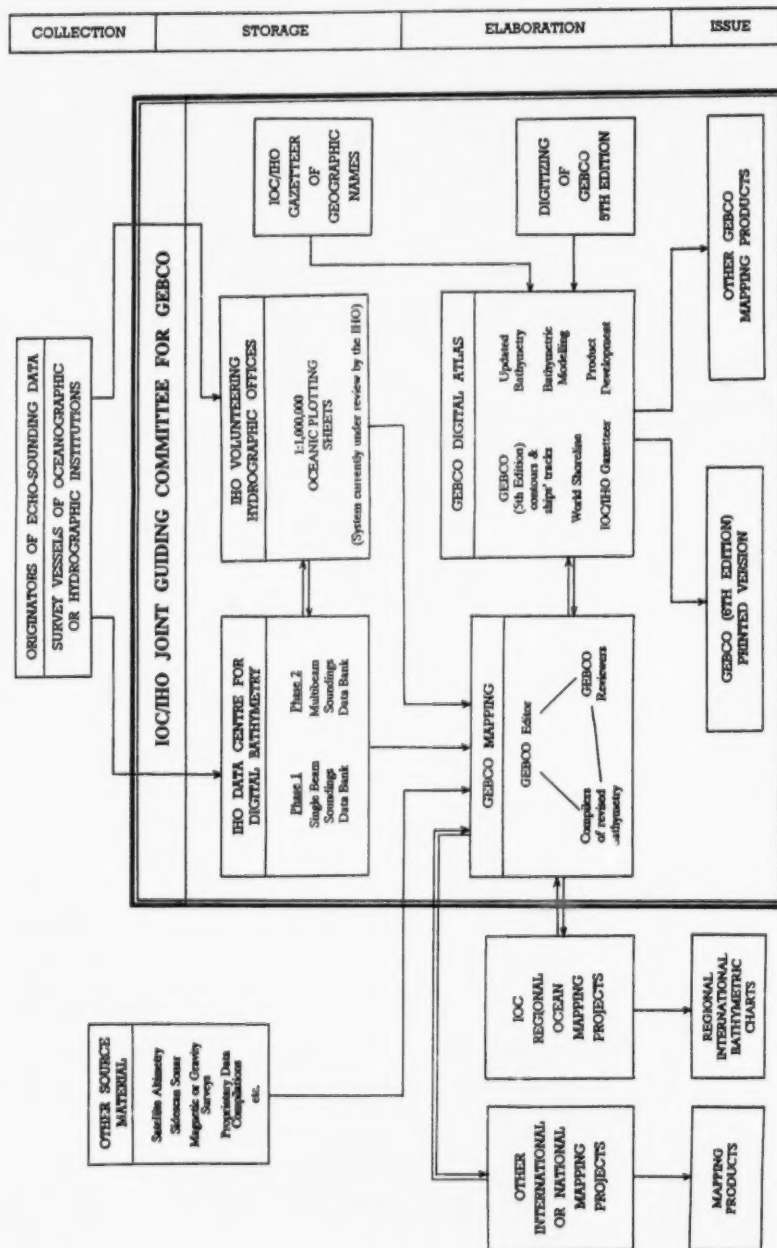
Overall, these activities constitute a significant contribution to the exploration and exploitation of the world's oceans.



GENERAL BATHYMETRIC CHART OF THE OCEANS (GEBCO)

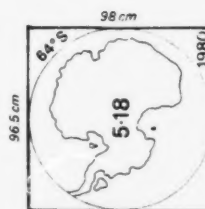
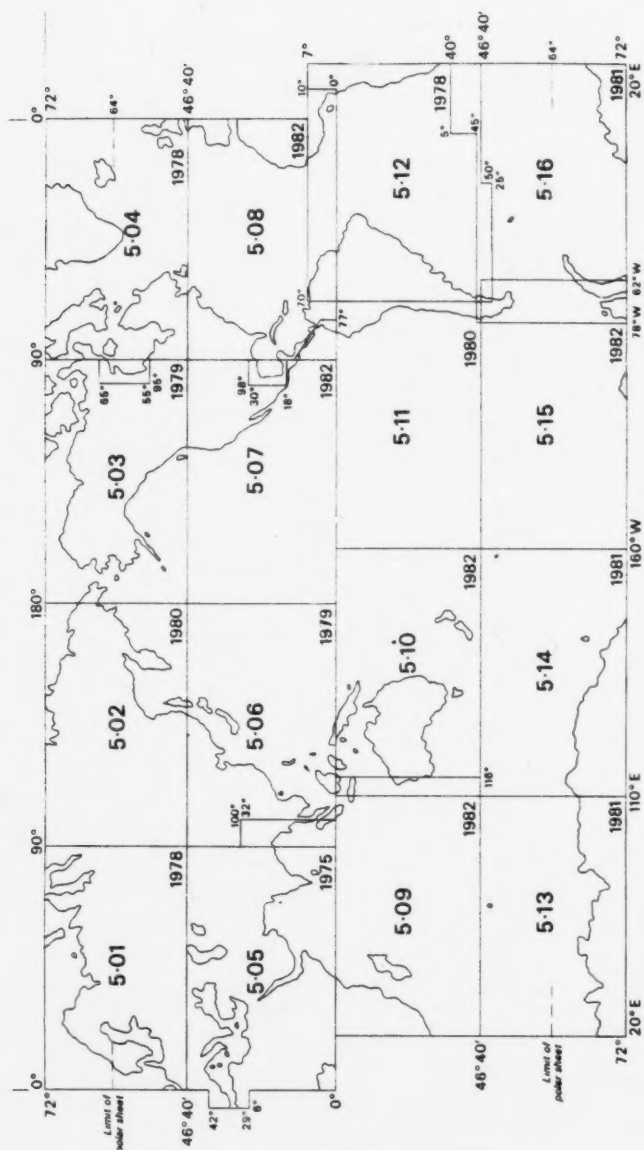


ANNEX I
GEBCO STRUCTURAL DIAGRAM

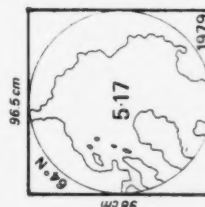


ANNEX II

GENERAL BATHYMETRIC CHART OF THE OCEANS

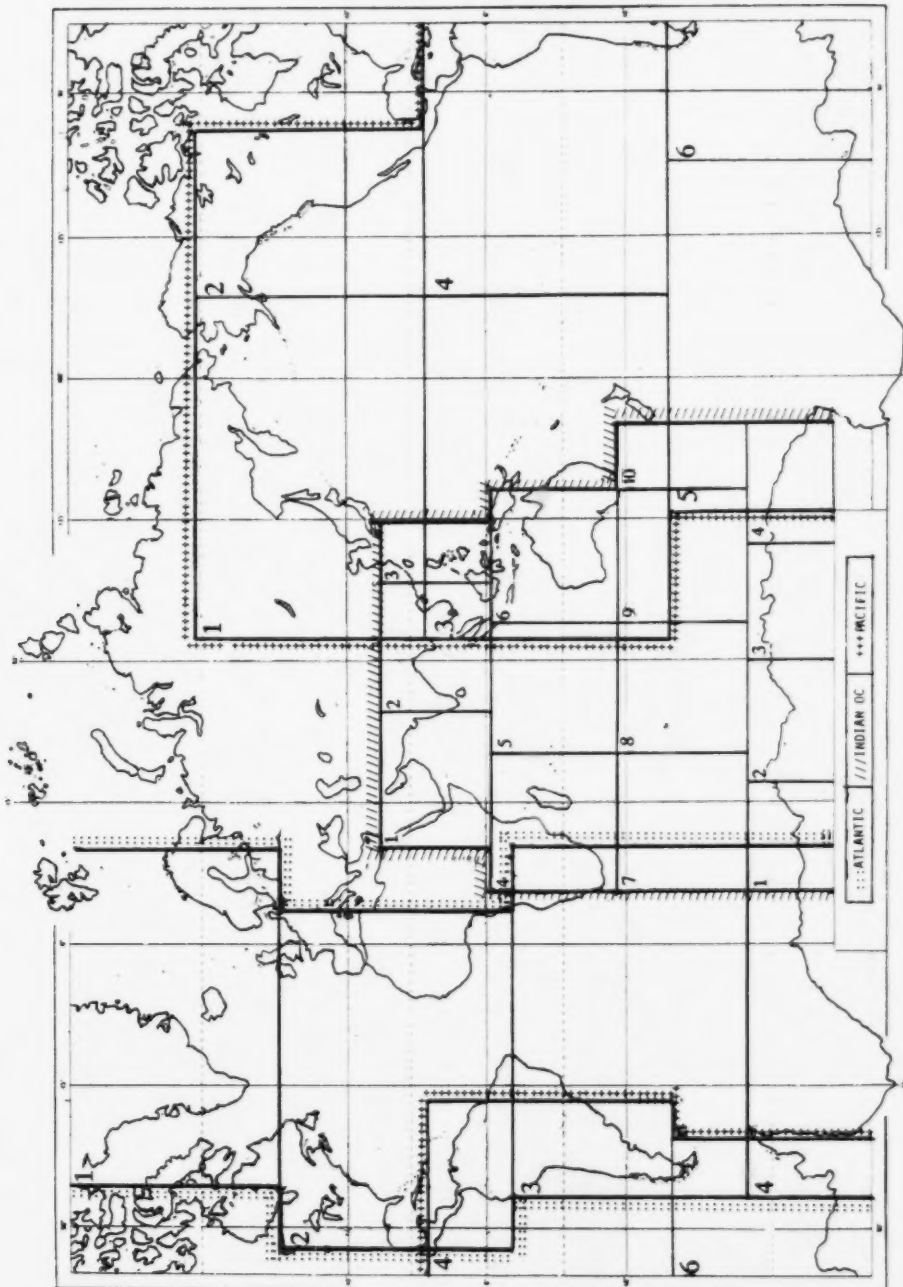


WORLD MAP
The 5th edition of GEBCO has been assembled into a single map of the world at a scale of 1:35 000 000 with the polar regions at 1:25 000 000.
This world map is identified as GEBCO 5.00



Scale 1:10 million at the equator

ANNEX II
THE GEOLOGICAL/GEOPHYSICAL ATLASES



ANNEX II
THE REGIONAL IOC OCEAN MAPPING PROJECTS

